Perceived Effectiveness of '*No Turn on Red*' Traffic Signs

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Abstract

This study examines the rated effectiveness of four designs of a 'no turn on red' traffic sign. Three existing designs were taken from the Manual on Uniform Traffic Control Devices (MUTCD). A fourth alternative design based on components of the other three signs was created for this study. Participants rated the signs on three characteristics: the likelihood that they would (a) notice, (b) understand, and (c) comply with the sign. They were also asked to rank the signs in order of overall effectiveness and answer several sign-related open-ended questions. The text-only sign was rated lowest on all three characteristics and was most often ranked as the least effective sign. The alternative design with the most elaborate symbol and complete set of words was rated significantly higher than the other three signs on all three characteristics and also ranked as most effective. Potential directions for future research are discussed and signage recommendations are made.

INTRODUCTION

In the 1970s most states in the U.S. began to allow vehicles to turn right at a red stop light after making a full stop and yielding to pedestrian traffic. Prior to this time, the law prohibited all turns on red. The change in law was due in part to a bill passed in the U.S. Congress which required every state to adopt an energy-savings plan (Zador, 1984). The passage of laws allowing right turn on red (RTOR) at traffic light signals sparked considerable research interest in the 1980s (Joksch, 1982; Preusser, Leaf, Debartolo, Blomberg, & Levvy, 1982; Zador, Moshman & Marcus 1982; Zegeer & Cynecki 1985; and Zegeer & Cynecki 1986). More recent research has investigated pedestrian safety issues at intersections where right turn on red is restricted by signage (Fleck & Yee, 2002; Retting, Nitzburg, Farmer, & Knoblauch, 2002).

Static 'no turn on red' (NTOR) traffic signs are frequently violated by motorists (Preusser, Leaf, Debartolo, Blomberg, & Levvy, 1982; Retting, Nitzburg, Farmer, & Knoblauch 2002; Zador, Moshman & Marcus 1982; Zegeer & Cynecki 1985; Zegeer & Cynecki 1986). At most U.S. intersections, turning right on red is legal and the sign is absent, so drivers may not be looking for a sign to indicate that it is permissible for them to turn right on red. One explanation for drivers' noncompliance is that they do not notice the signs. Other potential reasons for NTOR violations include: (a) failure to understand the words or reasons for the sign, (b) insufficient perceived importance, or (c) inadequate motivation to comply.

The present research examines aspects of several NTOR signs that could influence its effectiveness. In the present research, four signs were used. Three are currently displayed in the MUTCD, 2000. The fourth is an alternative design not in the MUTCD (2000) that was based on combining some of the components of the other signs. Most notably the fourth sign contains a complete word message (i.e., "NO TURN ON RED") and a large no right turn prohibition sign. The MUTCD signs lack one or more of these components.

The perceived effectiveness is measured using three ratings scales: likelihood to (a) notice, (b) understand the meaning quickly, and (c) comply. Signs were also ranked on overall effectiveness. Comments made by participants on why they made their choices were also examined. The goal was to determine which signs are perceived as more effective, why they are perceived to be effective, and how to improve them.

METHOD

Participants

Seventy-five participants were recruited from the Raleigh-Durham, North Carolina area. Thirty-eight participants were undergraduate students from North Carolina State University and 37 were non-students from the surrounding area. Participants ranged in age from 18 to 70 (M = 26.3, SD = 11.4. Forty-six were male (61.3%); 29 were female (38.7%). All participants were drivers holding a current license. The mean number of years driving was 10.7 (SD = 10.8). Sixty-six (88%) participants reported English as their first language.

Materials

The fours signs used in the survey were assigned and labeled with arbitrary letters: T, R, D, and W. These are

shown in Figure 1. All signs had black text on white background with black double-lined borders. Text characters were uppercase and approximately 3 cm (1.25 inches) high by 2.5 cm (1 inch) wide. Signs were approximately the same size, ranging 17.5-22.5 cm (7-9 inches) high and 17.5-20 cm (7-8 inches) wide. Signs T and R both have a red circle-slash prohibition symbol over a black right turn arrow. Sign T includes the full text message of four words "NO TURN ON RED," Sign R only includes a two word portion of the text message "ON RED." Sign D has the term "NO TURN ON RED" with a red-filled circle in the center.

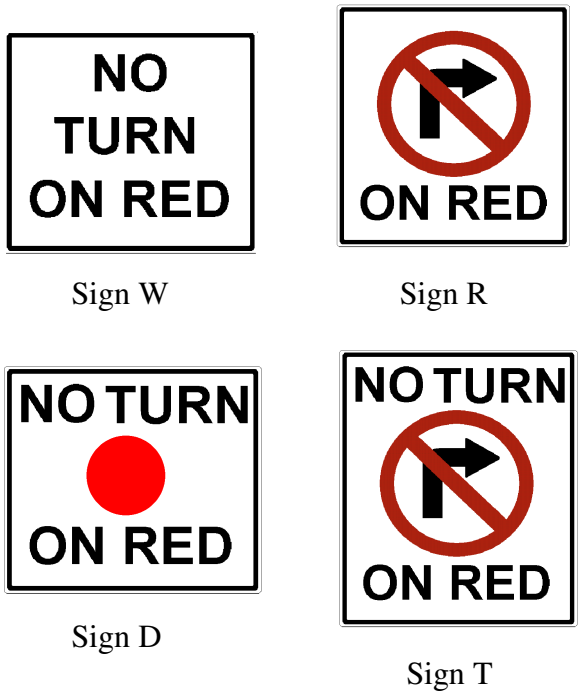

Figure 1 *The four sign designs. Signs W, R and D are from the 2000 MUTCD. Sign T is the alternative sign.*

The first three rating questions were:

(1) How likely are you to notice the sign?
(2) If you see the sign, how likely are you to understand it with a brief glance?
(3) Assuming you do see the sign, how likely are you to comply with it?

Each had a Likert-type scale with whole-number anchors ranging from one to seven. On the scale, 1 was labeled "not at all likely," 4 was labeled "somewhat likely" and 7 was labeled "extremely likely."

Next, participants were asked to "Rank the four signs on overall effectiveness." The most effective was given a rank of 1 with higher numbers representing lesser degrees of perceived effectiveness. Blanks were provided for participants' answers.

On the second page of the survey, open-ended questions were included. The first question was, "Why is the sign that you ranked as number 1, the most effective?" The second open-ended question was, "Why do you think that these signs are posted at some intersections?" The demographic section included questions about age, driving experience, language information, and gender.

Procedure

Participants were tested in groups of five or six, and asked to read the following scenario: "Imagine you are driving to work. You come to a red light. There are no other cars in front of you. You need to turn right. One of these signs is posted at the intersection. You may or may not see the sign. While keeping this scenario in mind, answer the following questions." All four signs were posted on a nearby wall simultaneously. Participants rated and then ranked the signs, and later answered a set of open-ended questions. Demographic information was collected at the end of the session.

RESULTS

No significant differences were observed when the results from a sub-sample of 38 students were compared to the results from 37 non-students. Thus, these sub-samples were collapsed into one data set.

Ratings

The first three rows of Table 1 present the mean ratings for the dimensions of perceived noticability, understandability, and likelihood to comply as a function of sign. All three questions produced a similar pattern of responses: Sign T was rated highest, followed by Sign R, then Sign D, and lastly by Sign W. Individual one-way analyses of variance (ANOVA) were applied to each of the rated dimensions. All were significant, $F(3, 222) = 100.99$, $p < .001$, $F(3, 222) = 32.82$, $p < .001$, $F(3, 222) = 28.82$ $p < .001$ for perceived likelihood to notice, understand and comply, respectively.

Table 1 *Mean ratings and rank as a function of sign design*

	Sign			
	W	**D**	**R**	**T**
Notice	3.35	4.57	5.41	6.40
Understand	4.51	5.20	5.76	6.55
Comply	4.79	5.01	5.75	6.08
Ranking	3.51	2.89	2.15	1.47

Note. Higher ratings and lower ranks indicate greater perceived effectiveness.

Pairwise comparisons among the signs for the notice and understand ratings were all significantly different from each other (*ps* <.001). For the comply ratings, all mean ratings were significantly different from one another (*p* <.01), except for the interval between Sign W and Sign D (*p* >.05).

Rankings

The sign ratings are shown in the bottom row of Table 1. Lower mean ranks indicate greater perceived effectiveness. The pattern of mean rankings is consistent with that of the ratings. Two participants failed to provide ranking data and were excluded from the analyses presented in this section. Sign T, the alternative sign with the complete text and prohibition symbol, was ranked most effective by 48 (64%) of the participants, followed by Sign R chosen by 19 (25.3%), and then by signs D and W each chosen by 3 (4%) participants. A Friedman test was conducted to evaluate differences in mean rankings of sign effectiveness (see Table 1). The test was significant, χ^2 (3, N = 73) = 103.44, p < .001, and the Kendall coefficient of concordance of .47 indicated strong differences in the mean rankings of the signs. Follow-up pairwise comparisons were conducted using a Wilcoxon test. All comparisons among the signs were significant (*ps* < .001).

Participant Comments

Answers to the open-ended question concerning the perceived safety reasons for the NTOR signs could have multiple responses per participant. For this reason, frequency was counted based on the observed occurrence, not by individual participant. When asked for specific reasons NTOR signs are posted: 25 (34.5%) participants said that the signs exist to decrease accidents, without elaboration; 23 (31.5%) responded the signs are at intersections where the view might be obstructed; 22 (30%) said that the signs are in places where traffic is heavy; 11 (15%) said the signs exist in areas where pedestrians cross; and 5 (6.8%) said that the signs are posted in places where the cross traffic is fast moving. Less frequently given responses included: a school being in the area, a train crossing, non-perpendicular roads, five-way intersections, and traffic turning from elsewhere. The findings for the other open-ended question are described in the next section.

DISCUSSION

The alternative design which has the complete message text (i.e., the words "NO TURN ON RED") and a red-colored prohibition symbol over a right turn arrow was rated the highest and ranked the best relative to the other three signs. The text-only sign (W), which is the standard NTOR sign according to the MUTCD, was judged to be the worst. The sign with a red-filled circle (Sign D) was perceived significantly more effective than the text-only sign in the dimensions of perceived likelihood to notice and perceived likelihood to understand. The sign with the partial text message (i.e., the words "ON RED") and prohibition right turn symbol (Sign R) was judged as significantly more effective than 2 signs with the complete text message (Signs D and W), however, it was rated less effective than Sign T. The pattern of ranking for overall effectiveness mirrored the ratings data.

Of those choosing Sign T as the most effective, 37 (49.3%) of them specifically stated that the combination of both words and symbols made it most effective, 18 (24.0%) mentioned that the red of the prohibition symbol was attention-grabbing, making it most noticeable, and 13 participants (17.3%) said that Sign T was "easy to understand." The use of color in Signs D, R, and T might explain why they were perceived as more noticeable than Sign W (which has black text only) in capturing attention. Because Sign D was rated as less effective than Signs R and T, color alone is not the only factor of consequence. The prohibition symbol is perceived to be more effective than the red circle as illustrated by the rating differences between Sign R and D. The prohibition symbol overall is larger but the red circle has approximately the same amount of red. The comparison between Signs R and D also suggests that the prohibition symbol makes a sign more effective, even when the accompanying text message is incomplete. Although Sign R has almost all of the components of Sign T, it lacks the complete text message. Participants were sensitive to this difference. Because the missing two words (i.e., "NO TURN") in Sign R mean the same thing as the prohibition symbol, participants apparently believed that they would benefit from the redundant combination of symbol and text present in Sign T relative to Sign R. These findings are consistent with previous research which illustrates increased comprehension for warning symbols with redundant words and pictorial messages (e.g., Sojourner & Wogalter, 1998). Thus, Sign T was rated as most effective because it combined the following components: (a) color, (b) prohibition symbol, and (c) redundant complete text message.

Some cognitive reasons for the present findings can be offered. Past research and theory indicates that the use of both text and pictures improves comprehension (Pavio, 1971). Improved comprehension of complete text and symbol coding extends to traffic signage (Barnes, Levine, and Wogalter, 2000). Previous research indicates that partial combinations of symbol and text may impede message comprehension (Morrow, Hier, Menard, & Leirer, 1998). Incomplete text messages (as is present in Sign R) may be more difficult to process verbally. Sign T may be a better combination of symbols and words because it not only gives redundant coding but also the symbol reinforces the meaning of the words "NO TURN." Because it requires translation of a picture code to a language code, Sign R requires translation of pictorial code to make sense of the incomplete wording. Participants commented that

they believed Sign T to be the most effective because: (a) it makes the message clear, (b) indicates that right turns are prohibited, and (c) catches attention with red on the sign.

The findings presented here suggest that the three NTOR signs currently in use may not be the most effective design for its purpose. The fourth alternative sign, not currently present in the MUTCD, was perceived to be better. In the present research, only four signs were tested and it is premature to suggest that Sign T is the optimal design. Other forms of NTOR signs should to be tested in future research. For example, Canada uses a symbol-only sign that includes a no-turn symbol with a traffic light symbol, but no words. Given situations such as international settings where text messages are limited by language comprehension, there is a need to conduct further studies of other signs in addition to the four presented here. Other forms of testing should also be considered. Tests of comprehension should be conducted by asking participants questions about the signs' message. From these studies, sources of confusion specific to each sign might be isolated. Sign noticability might be tested by determining how fast people notice each sign or the number of eye fixations it takes to notice the target sign in pictures of cluttered intersections. Finally, compliance might be measured with an observational study where Sign T or other improved signs are placed into service at intersections. Additional research on signage will likely result in improved traffic safety and the prevention of unnecessary injury and loss of life.

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